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DOCUMENT-IDENTIFIER: US 6687511 B2

TITLE: CDMA transmit peak power reduction

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INVENTOR-INFORMATION:

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US-CL-CURRENT: 455/522, 375/296 , 455/127.1

ABSTRACT:

A peak power regulator is disclosed that functions within a Code Division Multiple Access (CDMA) transmitter to reduce peak power spikes within baseband signals while maintaining the average output power consistent with the average input power, controlling the out-of-band emissions, and maintaining the in-band signal quality within an acceptable degradation. In-phase and quadrature baseband signals are input to a delay block and an envelope magnitude predictor within the peak power regulator. The envelope magnitude predictor outputs an estimate for the magnitude of the envelope that will be generated when the inputted baseband signals are modulated. This estimate is input to a multiplier that generates a ratio by dividing the estimate by a maximum acceptable envelope magnitude. The ratio is subsequently input to a mapping table that outputs a scaling factor sufficient for reducing peak power spikes. The scaling factor is subsequently input to an optional mean power regulator that generates an instantaneous gain value sufficient to maintain the average output power level at the average input power level. This gain value is applied to two multipliers that are also input with delayed versions of the in-phase and quadrature baseband input signals. The outputs from these two multipliers, after being filtered within lowpass filters to remove

out-of-band
emissions caused by the scaling, are output from the peak power
regulator.
These peak power reduced outputs have any peak power spikes scale
reduced while
maintaining the average power constant.

13 Claims, 11 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 8

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Abstract Text - ABTX (1):

A peak power regulator is disclosed that functions within a Code
Division
Multiple Access (CDMA) transmitter to reduce peak power spikes within
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signals while maintaining the average output power consistent with the
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input power, controlling the out-of-band emissions, and maintaining the
in-band
signal quality within an acceptable degradation. In-phase and
quadrature
baseband signals are input to a delay block and an envelope magnitude
predictor
within the peak power regulator. The envelope magnitude predictor
outputs an
estimate for the magnitude of the envelope that will be generated when
the
inputted baseband signals are modulated. This estimate is input to a
multiplier that generates a ratio by dividing the estimate by a maximum
acceptable envelope magnitude. The ratio is subsequently input to a
mapping
table that outputs a scaling factor sufficient for reducing peak power
spikes.
The scaling factor is subsequently input to an optional mean power
regulator
that generates an instantaneous gain value sufficient to maintain the
average
output power level at the average input power level. This gain value
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applied to two multipliers that are also input with delayed versions of
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in-phase and quadrature baseband input signals. The outputs from these
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multipliers, after being filtered within lowpass filters to remove
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emissions caused by the scaling, are output from the peak power
regulator.
These peak power reduced outputs have any peak power spikes scale
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maintaining the average power constant.

TITLE - TI (1):

CDMA transmit peak power reduction

Brief Summary Text - BSTX (4):

The use of Code Division Multiple Access (CDMA) technology is increasing within wireless applications such as cellular and Personal Communication Systems (PCS). Its utilization will continue to be significant as CDMA technology is incorporated within new standards such as the third generation (3G) Direct Spreading (DS)-CDMA communication system currently being defined. In CDMA technologies, multiple users and/or multiple data streams of each user, which each transmit information on a different code channel, share the same frequency channel, hereinafter referred to as a carrier. Furthermore, CDMA transmitters may also utilize multiple carriers, and therefore, multiple CDMA carriers share the same power amplifier and other components within a particular transmitter. This sharing of carriers between users and/or the sharing of power amplifiers and other components between carriers cause compounded signals to have a high Peak to Average Power Ratio (PAPR) to be processed by said components. In the 3G DS-CDMA standards, multiple code channels share the same carrier within 3G mobile stations. Hence, similar to that for a base station, compounded signals with potentially high PAPR are input to the power amplifiers of 3G mobile stations.

Brief Summary Text - BSTX (5):

In order to meet the out-of-band emissions requirements, a power amplifier and other components with this high PAPR input is required to provide good linearity in a large dynamic range. This makes the power amplifier one of the most expensive components within the communication system. The high PAPR also means that the power amplifier operation has low power efficiency. When considering the 3G DS-CDMA case, this low power efficiency reduces the battery life time for 3G mobile stations.

Brief Summary Text - BSTX (6):

An apparatus is thus needed that can reduce the PAPR of CDMA signals input to power amplifiers. Such a device should reduce the peaks of the compounded input signals such that a less expensive power amplifier can be utilized with out-of-band emissions still being fully controlled. This device should also be relatively inexpensive and any degradation in terms of in-band signal quality should be within an acceptable range.

Detailed Description Text - DETX (2):

Although the preferred embodiment of the present invention described herein below is incorporated within a CDMA transmitter, the present invention is not limited to such an implementation, but for example can be utilized in any transmitter in which peak power reduction and control of out-of-band emissions is required.

Detailed Description Text - DETX (3):

A single channel CDMA transmitter using a Baseband Peak Power Reduction (PPR) block according to a preferred embodiment of the present invention is now described with reference to FIG. 1. A Data Source (DS) 102 generates data streams 104 for transmission on multiple code channels corresponding to multiple users and/or multiple data streams for each user. These data streams 104 from the DS 102 are encoded, spread, and combined within a Channel Encoder and Spreader (CES) 106 which outputs an in-phase (I) baseband signal 108 and a quadrature (Q) baseband signal 110. The I and Q baseband signals 108, 110 are then pulse shaped by a Baseband Pulse Shaping Filter (BPSF) 112 that outputs pulse shaped I and Q baseband signals 114, 116 to a Baseband PPR block 118. The output from the Baseband PPR block 118 are peak power reduced baseband signals 120, 122 which are subsequently modulated within a Quadrature Modulator (QM) 124. The output signal 126 from the QM 124 is input to an Up-Converter (UC) 128 which shifts the frequency of the signals to the desired transmitting frequency. The up-converted signal 130 output from the UC 128 is input to Power Amplifier (PA) 132. The output signal 134 from the PA 132 is

filtered by
an RF Filter (RFF) 136 before being transmitted to the air through an
antenna
138.

Detailed Description Text - DETX (5):

FIG. 2 illustrates the preferred embodiment of the Baseband PPR
block 118
implemented within the single carrier transmitter depicted in FIG. 1.
This

Baseband PPR block 118 utilizes nonlinear baseband processing to
instantaneously scale the pulse shaped I and Q CDMA baseband signals
114,116 to
within an acceptable threshold range. The scaling of the baseband
signals
results in the envelope of modulated CDMA signals being equivalently
scaled to
a pre-configured magnitude threshold after quadrature modulation.

Detailed Description Text - DETX (7):

The squared envelope magnitude predictor 202, which is equivalent to
a power
estimation apparatus, estimates the squared magnitude of the modulated
CDMA
waveform envelope that would be formed by the baseband signals 114,116
after
quadrature modulation, hereinafter referred to as the squared envelope
magnitude, and outputs a signal representative of this squared envelope
magnitude. The squared envelope magnitude predictor 202, according to
this
preferred embodiment of the present invention, comprises a first
squarer 216
that multiplies the I baseband signal 114 by itself, a second squarer
218 that
multiplies the Q baseband signal 116 by itself, and an adder 220 that
sums the
outputs of the first and second squarers 216,218. The output from the
adder
220 is a squared envelope magnitude corresponding to the baseband
signals
114,116.

Detailed Description Text - DETX (19):

A multi-carrier CDMA transmitter, according to another preferred
embodiment,
using a Baseband PPR block is now described with reference to FIG. 3.
The
multi-carrier transmitter is similar to the single carrier transmitter
depicted
within FIG. 1, but the multi-carrier transmitter includes a plurality
of
pre-modulation carrier paths. In the example shown in FIG. 3, a
transmitter
with three carriers is depicted, though this is not meant to limit the

scope of
the present invention.

Detailed Description Text - DETX (49):

There are numerous advantages gained within the transmitter that utilizes a PPR block according to the present invention. The PPR block scales down the peak power periods while, in the preferred embodiments, maintaining the average power level, therefore reducing the CDMA Peak-to-Average Power Ratio (PAPR). This reduced PAPR is the most significant advantage of the present invention and results in the PA, within the transmitter, being capable of operating at higher average power levels while still satisfying the out-of-band emissions requirements.

Claims Text - CLTX (5):

5. A CDMA transmitter comprising: a data source coupled in series with a channel encoder and spreader, a baseband pulse shaping filter, and a quadrature modulators; an envelope magnitude regulator according to claim 4 input with the output from the quadrature modulator, the output from the quadrature modulator corresponding to the IF input signal; and an up-converter, input with the IF output signal, coupled in series with a power amplifier, a radio frequency filter, and an antenna.

Claims Text - CLTX (6):

6. A CDMA transmitter comprising: a plurality of data sources coupled in series with a plurality of channel encoder and spreaders, a plurality of baseband pulse shaping filters, and a plurality of quadrature modulators; a combiner, that combines the outputs from the quadrature modulators; an envelope magnitude regulator according to claim 4 input with the output from the combiner, the output from the combiner corresponding to the IF input signal; and an up-converter, input with the IF output signal, coupled in series with a multi-carrier power amplifier, a radio frequency filter, and an antenna.

Claims Text - CLTX (12):

12. A CDMA transmitter comprising: a data source coupled in series with a channel encoder and spreader, a baseband pulse shaping filter, and a quadrature modulator; an envelope magnitude regulator according to claim 11 input with the output from the quadrature modulator, the output from the quadrature modulator being the IF input signal; and an up-converter, input with the IF output signal, coupled in series with a power amplifier, a radio frequency filter, and an antenna.

Claims Text - CLTX (13):

13. A CDMA transmitter comprising: a plurality of data sources coupled in series with a plurality of channel encoder and spreaders, a plurality of baseband pulse shaping filters, and a plurality of quadrature modulators; a combiner, that combines the outputs from the quadrature modulators; an envelope magnitude regulator according to claim 11 input with the output from the combiner, the output from the combiner being the IF input signal; and an up-converter, input with the IF output signal, coupled in series with a multi-carrier power amplifier, a radio frequency filter, and an antenna.

Current US Original Classification - CCOR (1):

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DOCUMENT-IDENTIFIER: US 6144860 A

TITLE: System and method for controlling transmission power

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Detailed Description Text - DETX (43):

The multiplier 41 multiplies a pilot symbol by an estimated fading vector.
In the fading vector estimation, the phases are justified by multiplying a pilot signal by a complex conjugate of a theoretical value of the pilot signal.
Then, the composition of vectors in the same phase is performed. The resultant vector is averaged with the composite symbol number. A current fading can be estimated by performing a high-order interpolation using past fading vectors.

Current US Original Classification - CCOR (1):
455/522